REMARKS

In response to various paragraphs of the Office Action, applicants offer the following remarks:

1-2. Drawings

Figs. 3, 11 and 12 have been amended to include the reference designations noted by the Examiner. No new matter has been added.

Fig. 10 has been corrected, as requested by the Examiner.

3-5. Specification

As requested by the Examiner, applicants have now amended page 32, line 13, to state that "m" is an integer.

It is noted that the bottom of page 31 refers to "m arrays of the nozzles".

A substitute specification will be provided by the undersigned as soon as an electronic version of the specification is available.

6. Claims Objections

Claim 76 has been corrected, as requested by the Examiner.

7. Section 112 Rejections

Claims 51, 52, 54, 55, 57, 60 and 77-80 have been amended so that each has proper antecedent basis.

8. Section 102 Rejections

Claims 3, 44, 58, 61-64, 71 and 76 have been rejected as being anticipated by Michaelis. Applicants respectfully submit that this rejection is overcome for the reasons set forth below.

Amended claim 3 now includes features which are not suggested by the cited reference, namely:

- the piezoelectric block is an **integrally sintered one piece block structure**.

This feature is described in the specification, for example, at page 34, lines 14-26, as follows:

"The ink-jet recording head shown in Fig. 1 comprises a piezoelectric block 2 of the structure in which a fixed wall 6, an ink pressure chamber 3, a partition wall 4 serving as a driving portion having electrodes 7, and a pressure buffer chamber 5 are arranged in the same direction. The piezoelectric block configured in this way is referred to as a piezoelectric block (A). In this piezoelectric block, for example, piezoelectric ceramics powder is mixed with a binder, the resultant mixture is filled into a mold having a desired shape, and then, is removed from the mold, followed by baking. Alternatively, a die is molded with a burnable resin, **thereby providing a piezoelectric block which is sintered by baking integrally with the mold.**"

It is because applicants have an **integrally sintered one piece block** that applicants' invention realizes several advantages, as enumerated, for example, at page 13, line 15 to page 14, line 9:

> "[S]uch advantages can be produced that assembling work is unnecessary so as to reduce the number of

> processes, that no adhesion is necessary so as to easily form a predetermined shape without any consideration of dimension of an adhesive layer, and that the rigidity of the entire ink-jet recording head inclusive of the ink pressure chamber or the partition wall serving as the driving portion can be enhanced . . .
>
> Moreover, since there is no adhesive portion on the walls defining the ink pressure chamber so that the rigidity of the ink pressure chamber becomes high, ejection efficiency and ejection frequency become higher."

Michaelis, on the other hand, discloses a piezoelectric block including actuator walls 30, as shown in Fig. 1(b), which is **rigidly cemented** to base wall 20 and cover wall 22 (column 7, line 53 to column 8, line 1). Michaelis' structure is **not an integrally sintered one piece block structure, and cannot achieve the advantages realized by applicants' structure**, as recited in claim 3.

Since Michaelis' structure is **not** sintered, bonding faces between layers may be recognized. In applicants' invention, however, there is no bonding layer, because the structure is sintered. Reconsideration of claim 3 and dependent claims 44, 58, 61-64, 71 and 76 is requested.

Newly Added Claim 81

Claim 81 includes the features of claim 3 (without the sintering) and the following further features:

- surfaces of the two electrodes are oriented perpendicular to the thickness direction, the driving

portion is **polarized in the thickness direction and perpendicular to the surfaces of the electrodes.**

Basis for this feature may be seen, for example, from the description of page 24, line 7, to page 26, line 19. As stated, "the direction of the electric field and the polarizing direction are set in such a manner that the driving portion interposed between the plurality of electrodes are expanded or contracted in the same direction." (page 24, lines 13-16). The **polarization of the driving portion is in the thickness direction and perpendicular to the surfaces of the electrodes.** The thickness direction is shown, for example, in Fig. 3, and the surfaces of the two electrodes are oriented perpendicular to the thickness direction (the surfaces of the two electrodes are in a plane formed by the width direction and the length direction, as shown in Fig. 1).

Michaelis, on the other hand, discloses a polarized piezoelectric block in which the **polarization direction is parallel to the surfaces of the electrodes.** This is shown in Fig. 1(c) and described at column 7, lines 50-56. As indicated by arrows 320 and 330, the upper and lower parts 32 and 33 **are poled in opposite directions and are parallel to the surfaces of the electrodes (the surfaces of the electrodes are in the X, Z plane (X is into the paper).** Michaelis, in Fig. 1(c) does **not disclose an actuator wall in which the polarization direction is perpendicular to the surfaces of the electrodes.**

Furthermore, in Figs. 6(a)-6(b), Michaelis discloses electric fields 512 and 514 which are oppositely directed and perpendicular to electrodes provided at opposite ends of wall 500 (see Fig. 6(b) and col. 12, lines 12-40). This embodiment, however, is completely different from Applicants' invention, as recited. It is noted that, in Fig. 6(a), common face 506 moves in a **normal direction** to electric fields 512 and 514. This may be more clearly seen in enclosed redrawn Fig. 6(a) – redrawn as Figs. 6(a1) and 6(a2). As shown, common face 506(A) moves in direction "x", **normal to the electric fields.**

Applicants submit that the ink pressure chambers of Michaelis (which are **not** shown in Figs. 6(a) or 6(b)) are likely disposed along the "x" direction. (The pressure chamber would be squeezed or **driven** in the "x" direction). The "x" direction disclosed in Fig. 6(a) of Michaelis is arguably the "thickness direction" recited in claim 81. Therefore, Michaelis does **not disclose a driving portion that is polarized in the thickness direction ("x" direction), and perpendicular to the surfaces of the electrodes**, as recited in claim 81.

Newly Added Claim 82

Claim 82 depends from claim 81 and includes the polarization feature discussed above with respect to amended claim 3.

9-10. Section 103 Rejections

Claims 39, 42 and 46-50 have been rejected as being obvious in view of Michaelis. Claim 45 has been rejected as being obvious in view of Michaelis and Kishi.

Since each of these claims depends from claim 3, applicants respectfully submit that these claims are not subject to the rejection for at least the same reasons set forth for claim 3.

11-12. Allowable Subject Matter

Claims 1, 4, 5, 40, 41, 43, 53 and 56 have been allowed.

Claims 59, 65-70 and 72-75 have been objected to as being dependent upon a rejected base claim. Applicants respectfully submit that these claims are now allowable for at least the same reasons set forth for amended claim 3.

CONCLUSION

Claims 1, 4, 5, 40, 41, 43, 53 and 56 have been allowed.

Claims 3, 39, 42, 44-52, 54, 55 and 57-82 are in condition for allowance.

Respectfully Submitted,

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JJJ/lm/mjc/dm
Enclosure: Version With Markings Showing Changes Made
Figs. 3, 10, 11, 12
Illustrations of Fig. 6(a) of Michaelis

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The Assistant Commissioner for Patents is hereby authorized to charge payment to Deposit Account No. 18-0350 of any fees associated with this communication.

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2/4/02

VERSION WITH MARKINGS SHOWING CHANGES MADE

SPECIFICATION:

Specification at page 32, line 10:

This can be achieved if $X \leq P/m$, wherein X represents a deviation in the main scanning direction of one nozzle in an arbitrary nozzle array from another nozzle in a nozzle array nearest in the main scanning direction, m is an integer and P represents a pitch between the adjacent nozzles in one nozzle array. In the ink-jet recording head configured in this way, it is possible to align the nozzles projected in the sub-scanning direction at the highest aligning density. Consequently, it is possible to provide the ink-jet recording head capable of drawing an image of high quality.

CLAIMS:

1. (As Amended) An ink-jet recording head comprising at least one piezoelectric block ~~(A)~~ having (a) an ink pressure chamber communicating with a nozzle for ejecting ink supplied from an ink supply, (b) a partition wall serving as a driving portion that includes a piezoelectric element and at least two electrodes for driving said piezoelectric element, (c) a pressure buffer chamber, and (d) two fixed walls,

wherein said ink pressure chamber, said partition wall and said pressure buffer chamber are respectively arranged in sequence along a thickness direction of said piezoelectric block ~~(A)~~, and

one of said fixed walls is disposed adjacent to said ink pressure chamber and another of said fixed walls is disposed adjacent to said pressure buffer chamber.

3. (As Amended) An ink-jet recording head comprising at least one piezoelectric block ~~(B)~~ having (a) first and second ink pressure chambers, each pressure chamber communicating with a nozzle for ejecting ink supplied from

an ink supply, (b) first and second partition walls, each partition wall serving as a driving portion for one of the two ink pressure chambers, each partition wall including a piezoelectric element and at least two electrodes for driving said piezoelectric element, (c) a pressure buffer chamber, and (d) first and second fixed walls,

wherein the first ink pressure chamber, the first partition wall, said pressure buffer chamber, the second partition wall and the second ink pressure chamber are arranged in sequence along a thickness direction of said piezoelectric block ~~(B)~~,

said first fixed wall disposed adjacent to said first ink pressure chamber and said second fixed wall disposed adjacent to said second ink pressure chamber, and

the piezoelectric block is an integrally sintered one piece block structure.

5. (As Amended) The ink-jet recording head as set forth in claim 1, wherein said piezoelectric block ~~(A)~~ is a block molding molded integrally by baking powder including a piezoelectric material.

39. (As Amended) The ink-jet recording head as set forth in claim 3, wherein said piezoelectric block ~~(B)~~ is a block molding molded integrally by baking powder including a piezoelectric material.

44. (As Amended) The ink-jet recording head as set forth in claim 3, wherein said piezoelectric block ~~(B)~~ is repeatedly arranged in the thickness direction, or in a direction perpendicular to the thickness direction.

45. (As Amended) The ink-jet recording head as set forth in claim 3, wherein said piezoelectric block ~~(B)~~ is repeatedly arranged in the thickness direction, and in a direction perpendicular to the thickness direction.

46. (As Amended) The ink-jet recording head as set forth in claim 3, wherein at least two piezoelectric blocks ~~(B)~~ are integrated with each other by baking.

47. (As Amended) The ink-jet recording head as set forth in claim 3, wherein at least two piezoelectric blocks ~~(B)~~ are welded to each other via an adhesive.

48. (As Amended) The ink-jet recording head as set forth in claim 3, wherein at least two piezoelectric blocks ~~(B)~~ are arranged on a predetermined base member without being welded to each other.

49. (As Amended) The ink-jet recording head as set forth in claim 3, wherein a piezoelectric block assembly composed of at least two piezoelectric blocks ~~(B)~~ integrated with each other by baking is welded to another assembly composed of at least two piezoelectric blocks ~~(B)~~ integrated with each other by baking or is welded to said piezoelectric block ~~(B)~~ via an adhesive.

50. (As Amended) The ink-jet recording head as set forth in claim 3, wherein an assembly composed of at least two piezoelectric blocks ~~(B)~~ integrated with each other by baking is arranged on a predetermined base member without being welded to another assembly composed of at least two piezoelectric blocks ~~(B)~~ integrated with each other by baking or to said piezoelectric block ~~(B)~~.

51. (As Amended) The ink-jet recording head as set forth in claim 1, wherein a length of said fixed walls in the thickness direction is greater than that of said partition wall in the thickness direction.

52. (As Amended) The ink-jet recording head as set forth in claim 3, wherein a length of said fixed walls in the thickness direction is greater than that of said partition wall in the thickness direction.

54. (As Amended) The ink-jet recording head as set forth in claim 1, wherein each of said fixed walls includes a portion firmer than said partition wall.

55. (As Amended) The ink-jet recording head as set forth in claim 3, wherein each of said fixed walls includes a portion firmer than said partition wall.

57. (As Amended) The ink-jet recording head as set forth in claim 3, wherein each of said fixed walls includes a hollow portion.

60. (As Amended) The ink-jet recording head as set forth in claim 42, wherein each of said electrodes has a mesh-like structure.

76. (As Amended) The ink-jet recording head as set forth in claim 3, wherein a distance between said nozzles is constant in the ~~same~~ thickness direction.

77. (As Amended) The ink-jet recording head as set forth in claim 45, wherein m nozzle alignments, in which said nozzles communicating with said ink pressure chambers are aligned in an arbitrary number in the same direction as the moving direction of said ink-jet recording head in an ink-jet printer, are arranged in a direction perpendicular to the moving direction,

said nozzles are aligned without any overlapping in the direction perpendicular to the moving direction, and $X = P/m$

wherein X represents a deviation between said nozzles nearest each other out of said nozzles in reference to the moving direction, m represents an integer number of nozzles, and P represents a distance between said nozzles belonging to said same nozzle alignment.

Claims 81-82 are newly added.